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Bird's-eye View of Niagara Falls and Vicinity, Showing the Location of the Three Great Power Plants Now under Construction on the Canadian Side for the Development of a Total of 415,000 Horse-Power.

ELECTRICAL POWER DEVELOPMENTS AT NIAGARA FALLS.—I.—[See page 126.]

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NEW YORK, SATURDAY, AUGUST 12, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE ELECTRIC POWER DEVELOPMENTS AT NIAGARA FALLS.

The Niagara River, in its course from Lake Erie to Lake Ontario, falls a distance of 327 feet. A survey by the United States engineers who measured the flow of the river below the falls shows that it discharges 230,000 cubic feet of water per second from the one lake to the other. By a simple calculation it appears that in its descent of 27 miles from lake to lake, Niagara River develops the equivalent of about 9 million theoretical horse-power. If the whole of this 230,000 cubic feet of water and all of its 327-foot fall could be utilized in hydraulic-electric power plants, it must not be supposed that 9 million horse-power would be available for the various industries that might wish to use it. As a matter of fact only about 4½ million horse-power would be available, the other 50 per cent of the theoretical horse-power being consumed in overcoming the roughness of the river channel, friction in canals, sluices, penstocks, draft-tubes, etc., friction in the water turbines, and losses in the process of electric generation and distribution.

The fall of the river from the commencement of the cataracts, about three-quarters of a mile above the Falls, to the river below the Falls is about 210 feet, of which 50 feet occurs in the Rapids and 160 feet in the great Falls themselves. This is equivalent to 5 million theoretical horse-power, or say 2½ million horse-power available for industrial purposes. Between the head of the Whirlpool Rapids and the lower end of the Whirlpool there is another fall of 90 feet, and it is estimated that the 230,000 cubic feet of water per second, in its fall through this distance (most of which is included in the stupendous Whirlpool Rapids), has a theoretical capacity which if transformed into available power would represent about 1¼ million horse-power. The total energy developed by Niagara River in its course from just above the upper rapids to below the Whirlpool is equal to about 7½ million theoretical horse-power, or, if we allow for losses by friction, electrical generation, etc., it represents 3,750,000 horse-power that would be available for use in the industrial and for general power purposes.

At the present time, on both sides of the Niagara River, there are in operation or under construction electrical power plants whose combined horse-power is about 500,000. If we include the amount of power for which charter rights have been granted the total amount of power which will be developed at Niagara when the full limit of these charters has been reached will amount to over 900,000 horse-power. In the Scientific American Supplement of March 3, 1900, appeared a series of illustrated articles describing the development that had taken place at Niagara at that date. They included the 50,000-horse-power plant of the Niagara Power Company, and the 20,000-horse-power plant of the Niagara Falls Hydraulic Power and Manufacturing plant, which at that date were the only installations of any note. So successful was the first installation of the Niagara Falls Power Company, that a second power station of slightly larger size was commenced, raising the total power developed by that company to 105,000 horse-power. So quickly did these new ventures at Niagara establish their great commercial value that in the brief space of seven years the total development has increased on the New York side alone from 72,000 to 150,000 horse-power.

In the present issue we commence a series of articles on the present conditions at Niagara, in which the vast enterprises which are being carried through on the Canadian side of the river will be described and illustrated in full detail. The truly enormous scale on which the works have been planned is little understood, and it must come as a revelation to many of our readers.

It was inevitable the time should arrive when the public would be roused to protect Niagara Falls from the encroachments which were so rapidly being made upon it, and the fate of bills that were introduced at the last Legislature seeking further charter rights for the use of the Niagara water indicates that the public is well able to protect this splendid scenic feature from the absolute extinction which threatens to overtake it within the present generation.

THE CAUSE OF ACCIDENTS TO SUBMARINE BOATS.

In the course of an interesting lecture, recently delivered before the British Society of Naval Architects, relative to the subject of accidents to submarine boats, Capt. Bacon, the submarine expert to the British Admiralty, stated that, broadly speaking, submarine boats are liable to two classes of accidents—the admission of water into the interior, and explosion. Both have their counterpart in surface warships, namely, collision and boiler explosions or ammunition accidents. The confined spaces and small reserve of buoyancy of the submarine boat, however, intensify the danger to the crew. Water may enter a submarine boat through two causes—either through a hatch or through a leak, and in the case of such admissions protection can be exercised by the provision of watertight bulkheads. The most probable cause of water entering the boat is through a hatch, and in the four cases of foundering of submarines during the past few years the accidents have been attributable to this cause. The fact of the hatch being the primary source of weakness is very suggestive, and most reassuring as regards the safety of the boats; since, with the practical elimination of this source of danger, the main cause of accidents up to the present would be obviated. Of all the other possible causes of boats foundering from taking in water, it may be fairly claimed that the only one that was fairly possible was when the boat was injured by collision in the hull above the center line.

Only three causes of accident from explosion inside the boat are possible. To cause an explosion with gasoline, first a leakage is necessary, and secondly, a spark to ignite the mixture. A leakage, should it occur, can invariably be detected by the odor, but in a properly-designed system, leaks should be practically non-existent. Even with vapor in the boat no direct danger existed, provided the boat was properly ventilated and no switch was moved or anything done to cause a spark. As a matter of fact, in practise the smell of gasoline inside a boat was almost unknown.

In the accident to the British submarine boat "A5," where a gasoline explosion occurred, the cause of the leakage was a badly packed gland of the gasoline pump, the gland being screwed down metal to metal; but in spite of one man being overcome by the gasoline fumes the main motor was started, and the sparks determined the explosion. Had the very explicit and simple regulations provided been carried out, no accident would have occurred. The British boats have covered 30,000 miles under their engines and, with the exception of one small flash in an early boat, no explosion except that in "A5" has occurred. The second possible cause of an explosion is the hydrogen given off by the batteries in charging; but as this operation is only carried out when the boat is opened up for ventilation, no danger from this source should exist. The explosion which occurred recently in the British boat "A5," two hours after its foundering, was probably due to the formation of this gas. The third cause, namely, the failure of the air reservoirs, is but a mere possibility. It might, therefore, be assumed that danger to the boats from explosions is really small, and not greater in comparison than the dangers which attended the introduction of increased boiler and gun power in the navy as a whole.

AN EXCELLENT PRECEDENT.

If the attitude of the general public toward big corporations, and of these corporations to the general public, could be marked by the mutual consideration which has characterized the recent negotiations between the Merchants' Association and the New York Telephone Company, there is little doubt that the adjustment of rates and other debatable matters on a basis equitable to both parties concerned would, in many cases, be readily secured. How excellent are the results that have been obtained in the case in question may be judged from the fact that the New York Telephone Company has agreed to reduce its rates on direct lines from as much as twenty per cent for 600 messages to ten per cent for 4,500 messages. Under the new schedule, the old rate of $75 for 600 messages becomes $60, while for 2,400 messages the rate has been reduced from $165 to $135, and on 4,500 from $228 to $204. This gratifying reduction, which affects the boroughs of Manhattan and the Bronx, took effect some two months ago, and the credit for the reduction is due to the initiative of that most worthy body, the Merchants' Association, the list of whose successful agitations for the improvement of commercial and civic conditions of New York city is constantly growing.

It was in April, 1904, that the Merchants' Association took up with the New York Telephone Company the matter of telephone service and charges in this city, with a view to bringing about a reduction of rates in case it were found that the existing rates were excessive. The company offered to establish a new tariff if after a thorough investigation had been made it should be found that the company's profits exceeded ten per cent of the capital invested. Moreover they established a most notable and highly commendable precedent, by consenting to open their books and supply a committee of the Merchants' Association with all the necessary details of investment, gross earnings, operating expenses, and net earnings, as a preliminary to a readjustment of rates upon the agreed equitable basis, if such adjustment should be warranted by the facts disclosed by the investigation. The committee thereupon made provisions for an examination of the telephone company's accounts, and further examined personally and through experts into the financial and operating details of telephone management in this and such other cities as were germane to their purpose, with the result that the New York Telephone Company prepared and put into effect a new schedule of rates, some of the items of which we have given above, adjusted to the basis accepted by the special committee of the Merchants' Association as equitable.

The inquiry developed some interesting facts regarding the conditions of telephone service under varying conditions; and it was found that in all American cities having a population of over 50,000 there was a wide variation in the rates charged for telephone service. A close examination of the subject shows that a comparison of telephone rates in different cities fails to give correct deductions as to the reasonableness of rates in any given city. It was found that the outlay for labor, rent, taxes, real estate charges, etc., varies widely in the different cities of the world, those in America being much higher than those in Europe, and in America being much higher in large than in small cities. There are wide differences in the quality, range, and quantity of service rendered, particularly in the methods of charging for the service. There were differences also in the number of subscribers who take different grades of service. In 80 American cities having a population of over 50,000, the ratio of residence telephones to the total number of telephones varies from 15 per cent to 71 per cent; of party line telephones to total telephones from 4 to 84 per cent; of private branch exchange telephones to total telephones from 1 to 41 per cent, etc. There are also striking conditions peculiar to telephone business in large and small cities. In a small city a single central station suffices for prompt intercommunication between 2,000 or 3,000 users of individual stations. A single switchboard and single operator complete each connection called for, and the area served being comparatively small, the wire-mileage is relatively small. In large cities such simple conditions cannot, in the very nature of things, exist.

Ten years ago there were but 12,000 telephones in Manhattan and the Bronx. To-day there are more than 150,000. The system is by far the largest in existence, and is much larger than those of European cities of greater population. London, with a population of 6,580,000 in 1904, had 93,598 telephones, or 14.2 per 1,000 inhabitants. Paris, with 2,660,000 inhabitants, had 49,444 telephones, or 18.5 per 1,000 inhabitants. Berlin, with 1,931,000 inhabitants, had 66,744 telephones, or 34.5 per 1,000 inhabitants. But Manhattan and the Bronx, with 2,216,700 inhabitants, had the enormous number of 144,353 telephones, or 65.1 per 1,000 inhabitants.

A period of sixteen years was chosen by the Audit Company of New York for investigation, because it witnessed a complete conversion of the plant from an overhead single-wire system to an underground metallic circuit system, and again from the magneto-call local battery system to the automatic centralized battery system, as well as the great development of the system from some 12,000 to over 150,000 stations. Their investigation showed that the average percentage of net earnings to investment was as follows: For the fifteen years from January 1, 1889, to December 31, 1903, 10.89 per cent; for the sixteen years January 1, 1889, to December 31, 1904, 11.12 per cent, and for the year ended December 31, 1904, 14.54 per cent.

Of course no one supposes, nor does the New York Telephone Company claim, that this reduction is made on ground altruistic or Utopian, although the company is naturally solicitous for the good will of its vast number of patrons. As a matter of fact the reduction has been made in accordance with the well-understood economical law governing cases such as this, that a reduction in the price is, other things being equal, a sure means of securing a great extension of the service.

BLOOD CORPUSCLES ON MONT BLANC.

The red corpuscles of the blood have been counted by M. Raoul Bayeux during an ascension to Mt. Blanc, between Chamonix, Grands Mulets, and the summit. The samples were taken from the author and two other persons. After counting the globules at Chamonix, he made two determinations at Grands Mulets, the first shortly after arriving and the second the next day. At the Janssen Observatory, at the summit of Mt. Blanc,

the globules were counted after passing the night. The author then mounted to Grands Mulets alone from Chamonix and made another determination. He thus studied the action of a long ascension, the action of a short stay at a high altitude, then the passage to a still higher station, then a second ascension near the first. The red globules, diluted in Marcano serum, were numbered by a globule counter of the Malassey type, with a portable Zeiss microscope. He makes the determinations upon a quantity varying from 4 to 7 million globules, and forms a table from which he deducts the following conclusions: The blood undergoes a rapid and considerable increase in the number of red globules when we pass from one altitude to a higher level. If we remain in the latter place the first number of globules is found to diminish slightly, but not to a great extent in a few hours. Descending to the starting point makes the number diminish to a greater degree, but it is still above what it was before the ascension. He finds that a second ascension, made before the number has fallen to the original value, causes a new increase which is greater than is remarked in the first ascension. A subject who is acclimated to a greater degree is less subject to a change in the number of globules. This is the first time that the corpuscles have been counted at the summit of Mt. Blanc, which, it will be remembered, is the highest point in Europe.

A PRIZE FOR A NON-POISONOUS DIAMOND CUTTER'S COMPOSITION.

Considering the fact that the setting and resetting of diamonds for cutting purposes involves the use of an alloy, consisting of tin and lead, the handling of which has been ascertained to produce injurious effects, i. e., lead-poisoning, the government of the Netherlands has decided to open a competition under the following conditions.

The government desires a medium for the setting and resetting of diamonds to be cut—which need not necessarily be an alloy—the use of which cannot produce effects detrimental to the health of those handling the same, or an elaborate project of altering the method now in use, in such a manner that no such injurious effects can be produced.

The following requirements have further to be fulfilled:

1. The medium or the method must be practicable for all sizes and shapes of diamonds in the following branches of the diamond industry, viz., brilliants, roses, and so-called *non-recoupés*, now being cut in the Netherlands.

2. The application must be such as to be learned by the workmen, adapted to the present method of work, without any great difficulty, while the setting and resetting must not require more time, or considerably more time than is usual now.

3. The application and use must not entail considerable pecuniary outlay.

The Minister of the Interior has appointed a committee of experts to consider the answers submitted, and to award the prize. The answers must be written in the Dutch, French, English, or German language, and must be accompanied by samples or objects to enable the committee to form an opinion of the practical value of the invention, and also by a legibly written address of the competitor.

The answers, and the samples or objects pertaining thereto, must be sent carriage paid, and if sent from foreign countries duty paid, before January 1, 1906, to Prof. Dr. L. Aronstein, chairman of the committee, Chemical Laboratory of the Polytechnic School, Delft, Holland.

The prize to be awarded for a complete solution of the problem is six thousand florins. The committee is empowered to divide the prize among different competitors, or to award the prize partially in case of a partial solution of the problem, for instance if it is applicable to one of the above named branches of the diamond industry. The committee is also empowered to prescribe certain conditions, to be fulfilled by the competitor, before awarding the prize.

For the use of those who desire to enter the competition, the manner in which the diamond workers come in contact with the poisonous metal while engaged in setting and polishing is here briefly explained.

The metal, or solder, used, is an alloy, consisting of two parts of lead and one part of tin; by heating the composition becomes kneadable before melting; by cooling it regains its former firmness. This plasticity is an important property of the solder, as will be seen hereafter.

Before the polishing of the split and cut stones is commenced, they are given to the setter, who places them in a "dope," consisting of a nearly semi-spherical brass pan, into which a tough, thick copper wire is screwed. Into this pan solder is put, so that not only the pan is filled, but that a conical eminence is formed also, which is kneaded into shape.

When the solder is rendered kneadable by means of a gas flame, the "dope" is placed on a wooden block, called "verstelblok" (setting block); the diamond is then pushed into the top of the conical eminence by means of a pointed pair of iron pincers, so that only the facet or facets to be polished remain exposed; the setter then fastens the stone and smoothes the still plastic solder into shape with his unprotected fingers. The "dope" is then cooled and handed to the polisher.

Considering that one setter works for four or five polishers, and that about two hundred "dopes" have to be daily manipulated for each polisher (when the stones are very small this number is considerably larger), it is evident that the setter's fingers are constantly polluted with lead-laden particles, which easily attach themselves to the skin, while he is, moreover, exposed to the lead-laden fumes arising from the heating of the solder.

The polishing process is as follows:

The polisher is seated before a bench, in the center of which a metal disk is horizontally placed; this disk revolves rapidly on its own axis (about 2,400 revolutions a minute). The polishing medium consists of a mixture of pulverized diamond and olive oil. The "dopes," wherein the diamonds are fastened, are held by their copper wires in tongs, to which a fixed position in relation to the bench can be given; by bending the copper wire more or less the diamond is placed against the disk in the proper angle and is firmly pressed against the same by loading the tongs with heavy weights, for which purpose iron blocks are successfully used in Holland since 1904, instead of the leaden blocks that were used before them.

The friction occasioned by the polishing process creates a great heat, so that the "dopes" have to be repeatedly cooled. The "dope," however, never gets so warm locally that the solder turns soft, because it conducts heat well.

If the diamond were set in the cement (a mixture of resin, shellac, and sand), used in the processes of cutting and splitting, the "dope" would conduct the heat badly, turn soft, and the diamond would be immersed.

The constant manipulation, the ceaseless turning and bending of the "dopes" in the tongs (four tongs at least are being used on each bench), and also the fact that the stone and the solder-cone are wiped with the bare hand every time the polisher wants to see whether the facet has attained the required shape and size, are so many reasons why the polishers' hands are constantly polluted with particles of solder.

The way in which diamonds are cut and polished is therefore not without danger to the health of the workers. The setters and polishers are constantly in touch with metallic lead, which exposes them to the peril of chronic lead-intoxication, when no adequate precautions are observed.

Instances are given in the medical literature, a. o. by Dr. Coronel in the Netherlands' Medical Review (1864). Hirt, who verified Coronel's statement in 1870, relates that of ninety setters he examined in Mr. Coster's factory, about thirty showed traces of lead-poisoning. (Dr. L. Hirt, Die Krankheiten der Arbeiter, vide vol. I., die Staubinhalations-Krankheiten, p. 102.)

Dr. Pel, professor of medicine at the Municipal University of Amsterdam, has described a remarkable case of lead-poisoning in a diamond setter in the Centralblatt für innere Medizin, year 1897, No. 23. Dr. A. Norden, of Amsterdam, medical adviser to the Amalagamated Society of Diamond Workers (who examines the majority of the members of that society applying for sick pay), has had a large and varied experience on the subject. He drew attention to this important matter in the journal of the said organization, issues of June 28 and July 5, 1901 (Nos. 26 and 27).

PHOTOGRAPHING THE SOLAR CORONA.

BY J. W. DAVIDSON.

"Can a photograph of the solar corona be obtained without having to wait for the occurrence of a total eclipse of the sun?" is a momentous question in the astronomical mind at this time, especially in view of the approaching total solar eclipse which is to occur August 30, and to which eclipse expeditions are being dispatched. A distinguished scientist says: "Such a feat would be an astronomical discovery of the first rank."

It is now announced that Dr. Hausky, of the Odessa Observatory, in Russia, has succeded in obtaining such pictures from the summit of Mont Blanc and no less an authority than the veteran French astronomer, M. Janssen, who has seen the negatives, seems to be convinced that the actual corona has been photographed.

Dr. Hausky employed particular colored screens, through which he allowed the sunlight to pass before the image fell on the photographic plate. The negative thus obtained showed a nearly uniform halo around the solar disk. From this negative he produced a series of positives and negatives alternately, and treating them in a special manner he was able to produce the form and different degrees of intensity of the corona itself. The same form was constantly produced in spite of the changes in the position of the screens. On several occasions the problem has been considered solved, but further investigation showed that the image obtained was not that of the actual corona, especially in 1885-87—when a number of attempts were made to solve this intricate astronomical problem and a great deal was written on the subject at that time.

Now comes the suggestion which is the most plausible cause of renewed interest in the scientific world, of a probable solution of the problem; so great have been the improvements in photographic processes and in making colored screens, that it seemed quite possible that the object would soon be obtained.

Before, however, the problem can be considered solved it will be well to wait until the most crucial test can be applied, namely, that of photographing the sun by this means before or after a total eclipse, and then comparing the results with a picture taken during the eclipse with an ordinary camera. The test is a simple one, and the approaching eclipse of August 30 will present an early opportunity for carrying it out. Fortunately, the track of totality passes over some high mountains in the northern part of Spain, so that a high altitude is available.

SCIENCE NOTES.

Thus far it has been difficult to throw any light upon cell-absorption and selection in many complex natural relationships by calling in the assistance of the dissociation theory and the ionic relationships of the salts in the soil. The external relationships of nutrient salts, or the relative abundance of these in substrata supporting vegetation, constitutes a problem with which the physiologist must be concerned. It is necessary only to glance at the results of work done by various experiment stations in this country to be convinced of the great physiological importance which may be attached to such studies.

If, as has been well demonstrated, the germ of typhoid fever is transmitted principally in water, there seems no reason to doubt the ability of health officers, collaborating with broad-minded municipal authority and high-class engineering skill, to perfect means whereby this deadly germ shall be practically eliminated from our water supply. Consumption may be checked by the establishment of camps of detention where the unfortunate victims of this terrible disease may receive not only the highest degree of proficiency in medical treatment, but also be so segregated from the non-infected portions of the community as to render the spread of the disease difficult.

In point of quantity and value corn is the leading cereal crop of the United States. Its annual farm value in later years has nearly equaled and sometimes exceeded $1,000,000,000. While less subject to insect damage than wheat, the next most important cereal, the corn product would be considerably greater were it not for important insect pests. The work of several of these is obscure, and many farmers are entirely ignorant of the existence even of some of the worst enemies of this crop. In this last category falls the work of the corn root worm (*Diabrotica longicornis*), which ordinarily passes unnoticed, or at least is often misunderstood. The larva of this insect feeds on the roots of young corn, and in regions of bad attack may cause an almost entire loss of the stand. The corn root worm, together with one or two allied species working in substantially the same way, causes an annual loss of at least 2 per cent of the crop, or some $20,000,000.

Acccording to the annual report of the Royal British Observatory at Greenwich during the year ending May 10, 1905, 15,842 observations of transits were made of the sun, moon, planets, and fundamental stars. Great progress has also been made in the observation of the reference stars connected with the Greenwich section of the astrographic catalogue. This section extends from 65 deg. north declination to the North Pole, and in carrying out the measurement of the photographic plates, the accurate positions of 10,000 reference stars are desired. Of each of these stars five observations are desired, making 50,000 observations in all, and of this number 9,500 have been obtained during the past year. There now remain only five stars requiring three observations each, and 1,500 requiring one observation each, to complete the work; 603 double stars have been measured, 143 of these having their components less than one second of arc apart. A large number of photographs of Neptune and its satellite and 100 photographs of comets have been obtained during the year. The measurement of the catalogue plates for the Greenwich section of the International Astrographic Survey has been completed.

The losses occasioned by insects to farm products exhibit a wide range in different years, due, as a rule, to favorable or unfavorable climatic conditions, and also to the abundance, from time to time, of natural enemies. The result is more or less periodicity in the occurrence of bad insect years. In other words, periods of unusual abundance of particular insect pests are, as a rule, followed by a number of years of comparative scarcity. Furthermore, seasons which may be favorable to one insect may prove unfavorable to others, hence there may be not only periodicity in the occurrence of the same insect, but more or less of a rotation of the different insect pests of particular crops.

THE ASTROLABE OF REGIOMONTANUS.

BY CHARLES A. BRASSLER.

The subject of our present article, which we shall endeavor to describe as well as illustrate, is one of those intensely interesting instruments used by our forefathers for taking the altitude of the sun and stars at sea. It is the astrolabe of Regiomontanus, and it may still be seen in the Germanic Museum at Nuremberg. Who was this Regiomontanus? Johannes Müller by name, he was born at Königsberg in 1436, and he became an astronomer and mathematician of repute, in fact one of the greatest astronomers of the time, and like the great men of the day he affected the name of his native city, conferring thereby fame upon his birthplace, and assumed, therefore, the appellation *Regiomontanus*, meaning a Königsberger.

In connection with Bernhard Walther he built, in 1472, the first German observatory, where he conducted a series of the most exact observations with the beautiful instruments of his own invention and make, to which this astrolabe also belonged. A number of instruments of the kind that were employed upon shipboard sprang from his fertile brain; and it is certain that Columbus made use of the astronomical tables, compiled by Regiomontanus, for the determination of his whereabouts during his voyages and they must have played an important part in the later discoveries of the bold Genoese. It was Regiomontanus, too, who first studied the distances and motion of the comets.

Before the telescope was discovered, and it only came into use in 1610, all the practical astronomers busied themselves exclusively with measurements. To-day the telescope and the measuring instrument are combined and in this form the most exact observations of the stars are made possible; then the so-called *diopters* were employed and they had to be pointed at the stars. These were either tubes having small openings in either end through which one could see the star, or rulers of wood or metal, that carried at their lower end a perforated board and at the upper end a similar board used as a sight.

This method of observation, far from complete, required large and carefully-divided circles, that is, quarter circles or quadrants wherewith the height of the stars above the horizon or the distance between two stars could be measured; for the larger these quadrants the farther apart were the divisions representing degrees and as a consequence the more exactly was the operator enabled to read them off. Tycho Brahe, the great Danish astronomer of the sixteenth century, had worked with one of these large measuring instruments. According to Bürgel he had a huge quadrant let into a wall, called a wall quadrant, with a radius of more than three meters; the whole circuit of this immense instrument was nigh on to twenty meters. He was successful in obtaining very exact results with this. The astroblades were, however, much smaller, and also the results were greatly inferior to those obtained with the huge quadrants and octants. Indeed, they were never intended for the finest measurements. Since they were light and easily carried about, being from twenty to thirty centimeters in diameter, they were peculiarly adapted for seamen and travelers.

A clever observer such as Regiomontanus might obtain very exact measurements with a carefully-constructed astrolabe such as the one we show in the cut. The astrolabe was a sort of universal instrument. Not only could the height of a star above the horizon be measured by it and its distance from the zenith,

ASTROLABE OF REGIOMONTANUS.

but also many measurements, particularly the position of the sun, from which the local time and also the sidereal time could be obtained. When in use the astrolabe was suspended by the ring at the top or held freely in the hand so that the white line we see drawn across the face of the disk should fall exactly upon the horizon and in that way form the artificial horizon, while the vertical lines should be perpendicular to it. From this it is easy to see that an imperfect suspension of the instrument would lead to grave faults in the calculations.

The large disk, upon which the divisions of degrees are engraved, was made of metal; so also were all the other parts most carefully worked out of metal. *Mater* is the name given to the large disk divided into degrees. Inside of this is set a second metal plate, the so-called planisphere, and we can recognize it by the engraved net work. This net work comprises the degree-divisions of the heavens carried out upon a plane surface, hence the name (*sphaera*, the Latin word for a sphere, and *planum*, signifying a plane).

Above the planisphere lies the neatly cut out and decorated "rete" carrying upon its circular interior the constellations of the ecliptic. The pole of the ecliptic and the positions of some of the stars are also given.

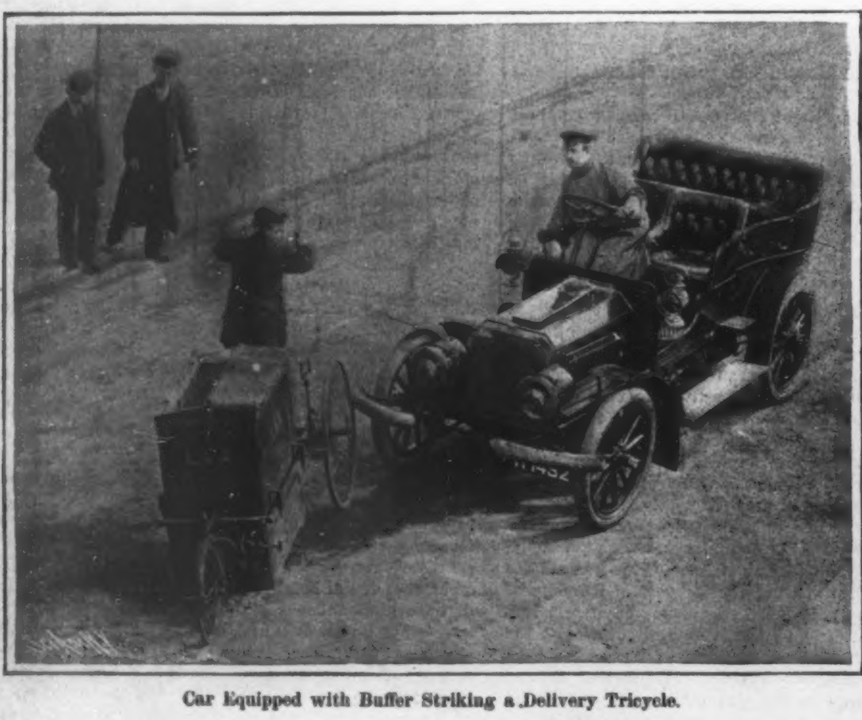
Turning upon the axis of the whole we finally find the *diopter rule*, called also the "Alhidad rule," the pointed ends of which serve as indicators for reading off the degrees on the outer circle. Slightly removed from the ends and approaching the center we see the little sighting boards with their holes for vision. If now we desire to find the local time we must proceed as follows: Hang up the astrolabe so that the plane of the mater coincides exactly with the plane of the sun's rays. Then, looking through the two holes in the diopter rule, turn it until the sun can be seen. Upon the extreme circle the height of the sun may now be read in degrees at the point of the diopter nearest the eye.

Now look up in the tables the position of the sun, the sun's longitude for this day in the ecliptic, and, by turning the "rete," bring the point on the ecliptic of the sun given for this day into coincidence with the height of the sun as measured by the diopter rule on the outer scale. A special pointer on the "rete" will now indicate a figure engraved upon the disk, which will correspond with the sun's time at the moment of the observation. The astrolabe in its positive form was invented by Hipparchus in the second century before Christ and until the beginning of the eighteenth century it was occasionally used, even though it did not give very exact results.

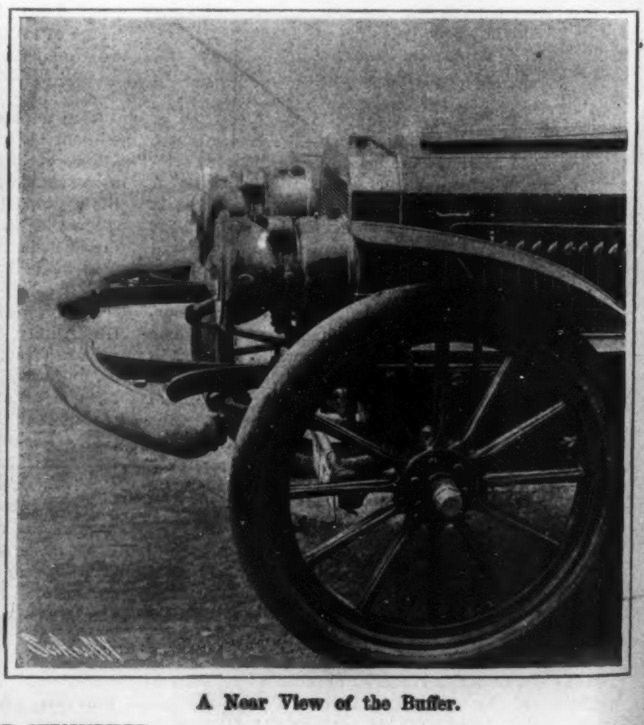
A SAFETY BUFFER FOR AUTOMOBILES.

Collisions by an automobile, either with stationary or moving objects, nearly always result in a certain amount of damage being inflicted upon the motor vehicle. As a rule it is the front lamps, mudguards, and, occasionally, the front wheels which suffer. With the object of minimizing this danger, and also for protecting the obstacles with which the car happens to collide, a novel safety buffer has been introduced by the Simms Motor Manufacturing Company, of London. As will be seen from the accompanying illustration, the device consists of two short rim segments attached either to the front or side members of the chassis of the automobile. To this rim is fixed a short length of pneumatic cushion, fully inflated. Being placed well in advance of the front of the vehicle, the lamps, mudguards, and wheels are adequately protected, and the curved nature of the buffer tends to transform the impact into a glancing blow. Owing to the bracket carrying the buffer being of stout construction and fashioned in the form of a spring, there is little possibility of the buffer collapsing or buckling by the force of the impact with another object.

The device has been subjected to several tests when fitted to a 20-horse-power car. The working of the buffer is well shown in the accompanying illustration.



Car Equipped with Buffer Striking a Delivery Tricycle.



A Near View of the Buffer.

A NOVEL PNEUMATIC SAFETY BUFFER FOR AUTOMOBILES.

If the obstacle is of a light nature, it is deflected and thrown out of the track of the car. On the other hand, should the collision be with a stationary object, the pneumatic buffer serves to take up the force of the shock and will also deflect the trajectory of the car to which it is fitted.

The application of this safety device is also being extended to power boats, for which it is well adapted. It is more efficient and safer than the type of fender ordinarily employed, and the effect of a collision with another boat would be considerably reduced in character. The danger of ramming is entirely obviated owing to the broad surface offered by the buffers.

THE ELECTROLYTIC PRODUCTION OF HYDROGEN AND OXYGEN FOR WELDING PURPOSES

BY DR. ALFRED GRADENWITZ.

Though the oxygen-hydrogen process of welding has so far given rather satisfactory results and should seem to be destined to replace the expensive familiar riveting and welding methods, the price of the oxygen and hydrogen gases, as produced by chemical methods, has been a serious drawback to its general adoption. As gases were supplied in the compressed state in steel bottles, which after being emptied had to be returned, the considerable transporting cost and renting fees were added to their own high price, due to the compression of the gases.

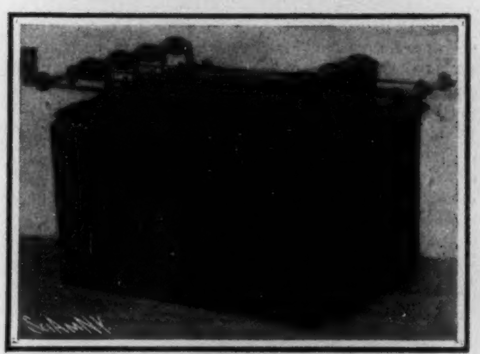
Of late years there have, however, been designed a number of outfits for the electrolytical production of the oxygen and hydrogen gases by the decomposition of water, two of which have proved fully satisfactory in working, namely, first, the Schuckert apparatus, and second, the Oerlikon electrolyzer. The latter, which has been described in detail by the writer in the SCIENTIFIC AMERICAN, No. 27, vol. 91, is being constructed also by the Siemens & Halske Company, and consists of a number of separate chambers, containing plate electrodes of cast iron, which are separated from one another by diaphragms. The gases set free at the electrodes are led through various pipe systems to separators, to be completely freed from any water, which flows back again into the electrolyzer.

In the following we wish to dwell at some length on the Schuckert type of apparatus, which is now being constructed by the Electrical Company, formerly Schuckert & Co., of Nuremberg, Germany.

These electrolyzers, photographs of which are reproduced herewith, are exceedingly safe to operate, on account of their simplicity of design. All parts of the apparatus are readily accessible, there is no material superintendence required, while a cleaning made once or twice per year is quite sufficient to keep the apparatus in working order. The electrolyzer has been designed especially with a view to its use for welding purposes, supplying the gas immediately under the pressure required for welding, so as to necessitate no compression. As gas is derived from the gasometers for the welding, the latter are being filled up by the electrolyzers, the generation of the gases occurring with perfect continuity.

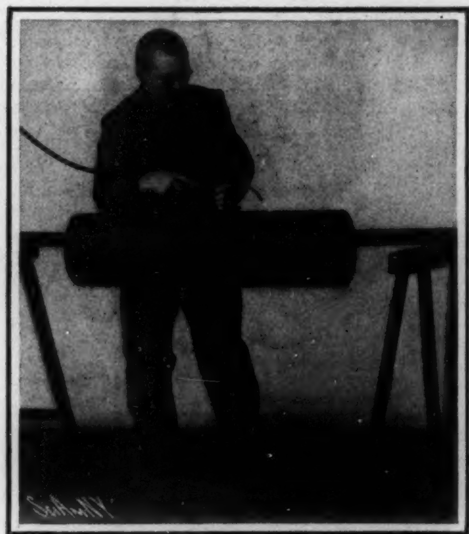
The apparatus, as can be seen above, consists of a cast iron tank, containing a number of cells, where the gases evolved on the electrodes are allowed to accumulate. Apart from the copper conductors, for supplying the current and from the insulation material, the apparatus is made up of iron throughout. A solution of 20 per cent caustic potash in water is used as electrolyte. A tension of from 2.3 to 3 volts is required for the operation of these apparatus, which are connected up either in series or in parallel, a proper amount of distilled water being filled in from time to time during operation. This is the whole of the superintendence required, in fact, no more than is necessary in the case of a storage battery of the same size.

The apparatus are protected against heat radiation by a sand layer about five centimeters in thickness, so as to maintain in the electrolyte a temperature of 70 to 75 deg. C., which is the most favorable; requiring the smallest potential difference for the decomposition of the electrolytic bath. The oxygen and hydrogen evolved by electrolysis are conducted each to a gasometer through separate pipes and thence to the neighborhood of the working place, there to be united in a burner, as they arrive in two separate



Apparatus for the Electrolytic Production of Oxygen and Hydrogen.

India rubber tubes, and to be burned in a pointed flame. This flame is carried over the sheets to be welded (which are applied to one another at an



How the Oxy-hydrogen Flame is Used in Welding.

obtuse angle) like an ordinary soldering flame, but without the agency of any special soldering matter, when the surfaces applied to one another become perfectly melted together. In order to give an idea of the cost of operation of the electrolytic process as compared with the chemical method, it should be mentioned that whereas "chemical" hydrogen as purchased in bottles will cost between 1.20 marks and 2 marks per cubic meter, and one cubic meter of oxygen works out at about 2.50 marks to 3.50 marks (apart from the cost of transport and the renting fees) the aggregate cost of producing one cubic meter of hydrogen and one-half cubic meter of oxygen by the electrolytic decomposition of water in Schuckert electrolyzers (supposing an average price of electric power) will range between 60 and 75 pfennigs, including interest and amortization of the whole plant. Under normal conditions, the cost of producing the gas mixture necessary for the welding of 1 meter of sheet iron 3 millimeters in thickness, will be about 15 to 20 pfennigs and will be effected readily in ten to fifteen minutes.

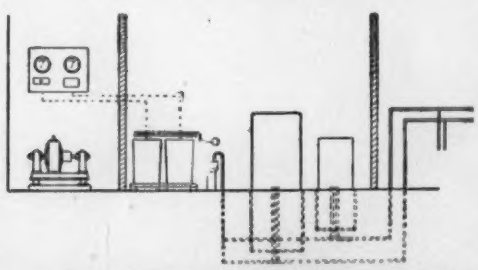


Diagram of the Plant for the Electrolytic Production of Oxygen and Hydrogen.

The gases supplied by the electrolyzer are of a high purity and perfectly safe against explosion; their efficiency is quite satisfactory. The operation can be discontinued and taken up again at any time without interfering with the satisfactory working of the apparatus.

Large Plant for Producing by Electrolysis 42,378 Cubic Feet of Hydrogen and 21,080 Cubic Feet of Oxygen in 24 Hours.

THE ELECTROLYTIC PRODUCTION OF HYDROGEN AND OXYGEN FOR WELDING PURPOSES.

Electricity in Egypt.

The German Consul at Alexandria gives some information as to the use of electricity for various purposes in Egypt. In Cairo we find that lighting current is generated by a station which the gas company controls, but the public lighting is not developed as yet and only private lighting is operated at present. A tramway system is working in the city. It is owned by a Brussels company. Alexandria is using current for private lighting, but, like Cairo, has no public system. The tramway lines are controlled by an Egyptian company. To connect Alexandria with its eastern suburbs, a concession has been granted to the Alexandria and Ramleh Railway, which has lately adopted electric traction on the lines. The same English company are now operating the city tramway lines. Port Said now has an electric lighting system, which is newly installed, but there are no electric tramways. At Mansourah, the public and private lighting is conceded to an English company for twenty years, dating from 1899. At Suez the concession for the electric lighting in the town and also at Port Tewfik was given to H. Beyts & Co. in 1902, but has now passed into the hands of the Ismailiah Electric Company. It seems that gas engines are to be used to a considerable extent in Egypt in the future. Motive power is employed almost exclusively for irrigation. The most common type of machine is the portable locomotive, of English construction, but it takes a great quantity of coal, and this is very expensive in a country like Egypt. It seems that these machines can be very advantageously replaced by gas engines, which are much more economical, especially the latest forms, which are well adapted for use here, and consume only 1.3 pound of anthracite coal per horse-power-hour. Transport of force would be a great advantage in Egypt for operating the small irrigating machines. It will no doubt come into use soon, and a start has been made by a French engineer. He employs the engines of a cotton factory which is not always running, to operate dynamos and send current for working electric pumps to carry out the irrigation. On one plantation a Siemens-Schuckert electric plant gives power for motors. Prince Djemil Tussum has also adopted a German electric station on his property for the same purpose. It will be remembered that the gates of the celebrated Asswan dam are operated by Siemens-Schuckert electric motors. There is some question of using the cataracts of the Nile as a source of hydraulic power to operate electric plants and distribute current throughout a region which is now a desert, but which would be flourishing could the Nile water be taken through it. Thus the river would give the irrigation water and also the motive power. But this project is one which remains for the future to solve.

The Largest Flower.

Sumatra grows the largest flower in the world. It measures a yard and three inches across, and its cup will hold six quarts of water. *Rafflesia Arnoldii* is its name.—Philadelphia Bulletin.

THE NEW JERSEY TUNNELS AND SUBWAYS.

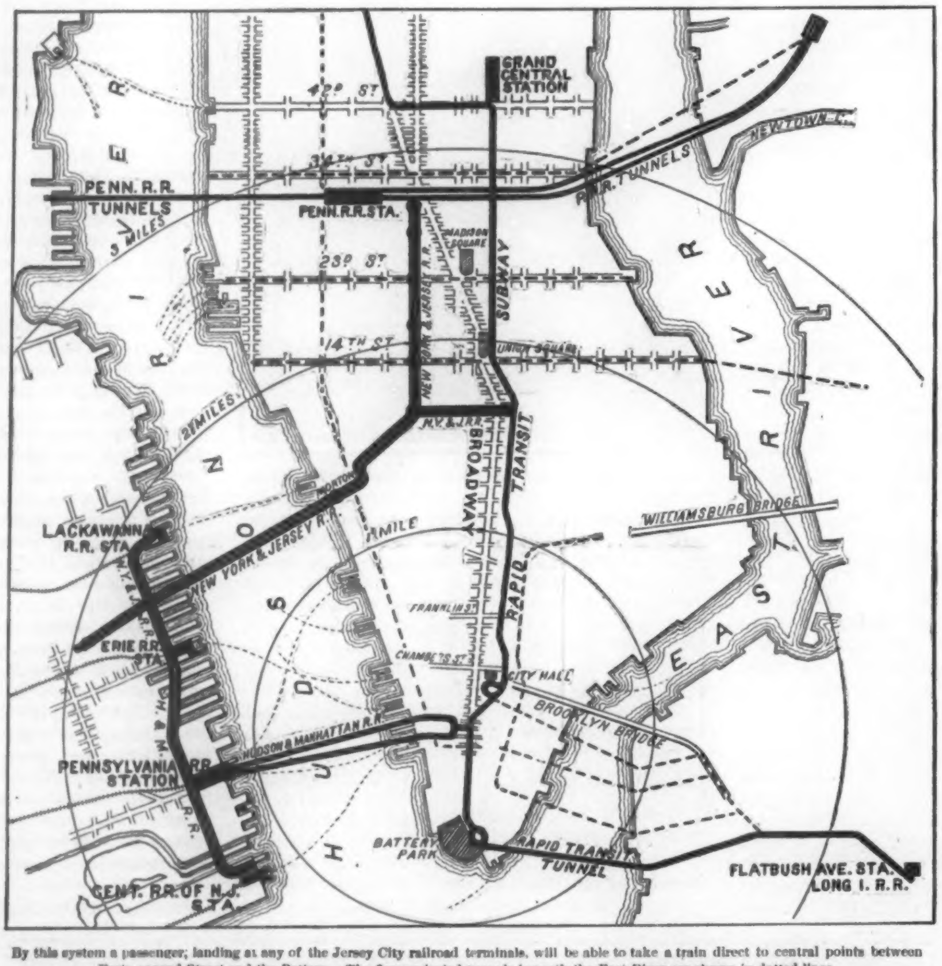
If the original company which undertook in the year 1874 the task of driving a tunnel from Jersey City to Manhattan beneath the Hudson River, and failed, could see the comprehensive system of subways and tunnels which is now being constructed by the Hudson companies, they would at least have the satisfaction of realizing that they had inaugurated one of the most important systems of underground railways in the world. When, in the year 1902, Mr. W. G. McAdoo resolved to take hold of the uncompleted tunnel and push it through to the Manhattan side, public interest in the scheme was altogether dead; but realizing how great was the advantage that would be conferred by a direct rail connection, and foreseeing how vast would be the growth in popularity of a means of transit that would be so much more comprehensive and expeditious than the ferry system, he not only succeeded in pushing through the original scheme, but he and his associates have extended it on the ambitious scale shown in the accompanying engraving. Briefly stated, the object of the subways and tunnels is to place the great terminal stations of the railroads, in Jersey City, in direct railroad communication with the various business centers on Manhattan Island, so that a passenger on arriving at any one of these terminals, can take a train which, in a few minutes' time, will land him without change of cars, either in the neighborhood of lower Broadway and Fulton or Cortlandt Streets or at any point on Sixth Avenue from Ninth to Thirty-third Street, or on Ninth Street from Sixth Avenue to Fourth Avenue. These tunnels will also afford rapid transportation for trolley-car passengers and for the thousands who walk to the ferries on the Jersey side from their homes.

The Jersey City terminals will be connected by a double-track system, consisting of two 15-foot tubes placed side by side, with a single track in each, which will extend from the Delaware, Lackawanna & Western Railroad, along the shore line to the terminal of the Central Railroad of New Jersey. At the D., L. & W. terminal the tracks will be near the surface, with the rails at a level of about 15 feet below street grade. From that point they will descend to 30 feet below street grade at the Erie terminal. At the Pennsylvania terminal they will be 70 feet below street grade; and from that point they will ascend to an elevation of 15 feet below grade at the terminal of the Central Railroad of New Jersey. At the point where this shore subway passes under the foot of Fifteenth Street, in Jersey City, it will be intersected by twin tunnels which will extend from Thirteenth and Fourteenth Streets and Provost Street to the subway, whence they will pass below the Hudson River to a station at Morton Street, in Manhattan. Thence they will be continued up Morton Street to Greenwich and Christopher Streets, where there will be a station, and thence up Christopher Street to a station at the junction of Ninth Street and Sixth Avenue. Here the system will branch into two separate pairs of tunnels, one of which will be carried below Ninth Street to Fourth Avenue to a connection with the existing Fourth Avenue Rapid Transit Subway. The other branch will continue north below Sixth Avenue, with stations at Fourteenth, Eighteenth, Twenty-third, Twenty-eighth, and Thirty-third Streets. The surface of the rail in these tunnels below Manhattan Island will be at an average depth of 33 feet below street grade. At Thirty-third Street the system will be in touch with the Pennsylvania Railroad tunnel across Manhattan Island, so that this portion of the road, or what is known as the Uptown Tunnel, will tap two important systems of underground travel, namely, the Rapid Transit Subway on Manhattan Island, and the Pennsylvania Railroad tunnels connecting with the whole of the Long Island Railroad system. The portion of the new tunnel above described, including the Jersey subway, as far as the Erie Railroad station, is being built by the New York and Jersey Railroad Company. The rest of the system, including the subway from the Erie terminal southward to the terminal of the Central Railroad of New Jersey, and the twin tunnels extending from the Pennsylvania Railroad terminal to Manhattan Island, with a loop on Church Street, is being built by the Hudson and Manhattan Railroad Company; and the contract for the construction of the whole of the work has been undertaken by what is known as the Hudson Companies. The downtown tunnel will consist, like the rest of the system, of two separate tubes with a single track in each. It will extend from the Pennsylvania Railroad terminal to Cortlandt Street, which it will follow as far as Church Street, below which it will pass in a loop, to return below Fulton Street and under the Hudson River to the Pennsylvania Railroad terminal.

In the earliest stages of the development of this enterprise, it was proposed to utilize these tunnels for running the steam railroad cars of the railroads terminating in New Jersey directly into New York; but as the present companies realized the full magnitude and importance of the enterprise, they very wisely determined to equip the system with the most up-to-date rolling stock and plant, designed especially for its use, and to follow in general the high class of construction which has been used in the Manhattan Rapid Transit subways. The rolling stock, therefore, will be entirely new. The cars will be large and brilliantly lighted; they will be constructed of steel and rendered absolutely fireproof. The protected third rail will be installed, and there will be a complete system of signals of the automatic and semi-automatic type placed throughout the whole line. In the subway on the Jersey City side and under Manhattan, where the service will be local in character, the trains will be run probably at about the same speed as those on the Manhattan Subway. In the tunnels below the Hudson River, however, where there are no stops, the trains will be run at express speed. This means that a passenger alighting, say at the Erie or D., L. & W. or, indeed, any of the terminals, can be in Manhattan in four or five minutes' time, and at Thirty-third Street, Fourth Avenue and Ninth Street, or at Fulton and Broadway, within from five to twelve minutes from the time he takes the tunnel train.

The present condition of the work is that, on the uptown tunnels, the north tunnel is completed from the shaft on the Jersey side to the shaft on the New York side, and the south tunnel is completed from the Jersey side to within 50 feet of the New York shaft. Work is also progressing on the approaches in New York. Of the downtown tunnels, the working shaft on the New Jersey side has been sunk, and the work of driving the two tunnels will shortly be under way, both tunnels being driven simultaneously. It is intended to use the shield method of construction with iron segmental tunnel lining for the whole of the system, not merely for that portion that lies beneath the Hudson River, but also for the subway beneath Jersey City and Manhattan. It is expected that the whole work will be opened to the public in from two to three years' time.

As showing the great activity in the work of connecting Manhattan Island with the mainland by tunnels, we have included on our map the tunnels of the Rapid Transit Subway and of the Pennsylvania Railroad that are now either under construction or have been authorized for construction by the Rapid Transit Commission. The most northerly of these are the Pennsylvania Railroad tunnels, which extend in the neighborhood of Thirty-third Street from New Jersey below the Hudson River, Manhattan Island and the East River to a station in Long Island City. These tunnels will not only give the Pennsylvania Railroad system a large terminal station in the heart of Manhattan Island, but they will place the network of railroads on Long Island in direct railway communication with Manhattan. The two Pennsylvania Railroad tunnels leading into Long Island will be below Thirty-second and Thirty-third Streets, and those which will extend to Jersey City will lie below Thirty-second Street. The other tunnel that is now under construction, is that of the Rapid Transit Road, which extends from the Battery below the East River to the foot of Joralemon Street.



By this system a passenger, landing at any of the Jersey City railroad terminals, will be able to take a train direct to central points between Forty-second Street and the Battery. The five projected tunnels beneath the East River are shown in dotted lines.

MAP SHOWING THE NEW JERSEY TUNNELS AND SUBWAY; ALSO THE EAST RIVER TUNNELS RECENTLY AUTHORIZED BY THE RAPID TRANSIT COMMISSION.

The opening of the Rapid Transit tunnel and its remarkable success had the immediate effect of awakening a keen competition among capitalists to secure franchises for the construction of further subways and tunnels, both in Manhattan and Brooklyn. With commendable foresight, Mr. Rice, the present acting chief engineer of the Rapid Transit Commission, had prepared extensive surveys for future roads, and recently the Rapid Transit Commission and the Board of Estimate and Apportionment have authorized the construction of no less than nineteen different subways. Included in and forming part of these various routes are five tunnels beneath the East River. The first of these extends parallel with the Pennsylvania tunnels across the East River and connects with the crosstown subway below Thirty-fourth Street. Another tunnel has been authorized from Brooklyn to Fourteenth Street. This last has been laid out with a view to its probable use by the Brooklyn Rapid Transit. It will connect through the Subway below Fourteenth Street, with a loop system running from Fourteenth Street through University Place and Wooster Street to Canal Street and thence returning over the Manhattan Bridge to Brooklyn. This loop will provide a route by which the Brooklyn surface cars can pass over to Manhattan Island and return. The same Fourteenth Street Subway will form part of a loop for the Brooklyn Rapid Transit elevated cars which will run down Fourteenth Street to Greenwich, down Greenwich to Liberty, and through Liberty Street and Maiden Lane to return to Brooklyn by a tunnel under the East River from Maiden Lane to Pineapple Street. For the accommodation of the Belmont interests, should they be disposed to bid upon it, a subway and tunnel have been laid out from the loop below City Hall Park, through Beekman Street and under the East River to Cranberry Street, Brooklyn. Another tunnel, which will probably form part of the system of subways which the

New York City Railroad Company is anxious to build, will extend from Montague Street, Brooklyn, under the East River, to Old Slip, New York, to connect with a subway under William Street. It is probable that all of these tunnels and the connecting subways beneath the avenues and streets of Manhattan will be in a condition for bids by the spring of 1906, and although only a part of them may be undertaken at once, it is probable that before another decade has passed, everyone of the lines indicated on our map will be in active operation.

Engineering Notes.

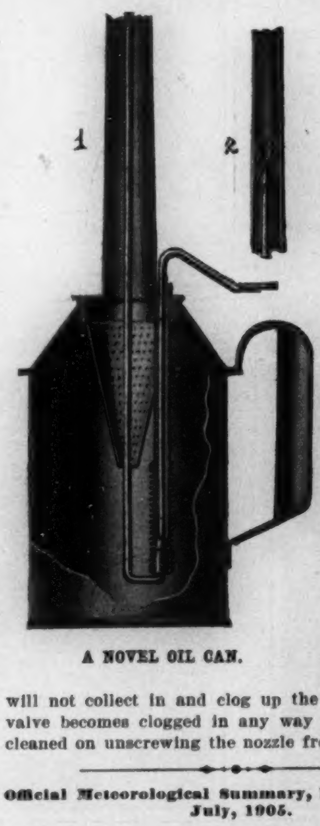
About 1890, some railroads commenced to build small spans and plate girders of steel, and, for eyebars, steel was almost exclusively used. At that time most of the rolling mills, which had formerly manufactured wrought iron, were equipped with steel furnaces, but continued for some time to make both kinds of material, until they found it more profitable to confine themselves to the manufacture of structural steel only, and discontinued the manufacture of wrought iron. In 1894, it was practically impossible to obtain wrought iron shapes, and from that time forward steel entirely superseded wrought iron as the modern structural material. The year 1894, therefore, may be considered as the commencement of the present epoch—the steel age.

There are different methods of executing laboratory instruction in engineering schools, and these range from the complete written-instructions method, which might be carried out by any intelligent man, to the pure research method, in which a problem is assigned and no assistance given for solution except facilities of laboratory and library. Equipment for such laboratory instruction is also quite various in kind and excellence, but on the average represents large outlays of money for installation and maintenance. It is difficult to see how all the schools with variety of apparatus and method of using the same can accomplish the same ends, and it may be that much of our apparatus is useless, as charged by some English critics. From the discussion, however, it does seem that the aim of the instruction, or the object to be attained by the student, may justify both method and apparatus, and that old, worn or small pieces will suffice when the aim is to teach the commercial tests, in which case also the complete printed report form is satisfactory. When, however, it is the aim of the instruction to make useful engineers, in the highest sense, by sending out bold and clear-thinking men, well equipped with the fundamental principles and their application, then the modified research method in some form is absolutely necessary. In this case the great range of problems and variety of the scientific foundation material make the most complete laboratory none too good nor need any part of it lie idle for want of usefulness.

At a recent meeting of the Belgian Electrical Society, J. Carlier reviews the different apparatus which have been designed for taking the speed of locomotives. The "kinemometers" of Richard and Jacquemier are not easily applied to locomotives, on account of the fragility of the different parts of their mechanism. But for experimental cars they have a better chance of succeeding, as the latter are less subject to heavy shocks. M. Hayne has devised a registering speed indicator for locomotives which is of strong build. It has a revolving disk, which turns proportionally with the time by a clockwork movement. It works by friction against a roller, which is mounted on a shaft carrying a screw-thread. The screw works in a nut, which is drawn in the opposite direction by the movement of the car wheels. Thus the roller moves over the disk at a distance from the center which is proportional to the speed. The Hausschelter register is used to indicate upon a dial, in front of the engineer, the speed of the locomotive in miles per hour. Besides, it registers on a band of paper, which rolls out proportionally with the time, the speed, the duration of the run, and of the stops. When the speed exceeds the proper limit, a bell is rung. Dr. Hasler, of Berne, has devised an instrument which may be an improvement on the above. It is a totalizing speed counter, indicating the speed at intervals of time which are three times nearer together than the above instrument. It registers the speed of the train, the total time of the locomotive, the length of the distance passed over, and is also to be adapted for recording the air-brake pressure. The speed of the train is represented by an irregular curve, which utilizes nearly the whole width of the paper band, and the point works every three seconds. In the Pennati tachymeter, the pencil-holder is raised along a vertical rod by means of a half-nut running upon a screw. At intervals of twenty seconds an electro-magnet works the pencil lever, so as to separate the nut from the screw. The speed is taken by a wheel running upon the rail, and its shaft operates the gearing of the apparatus. Electric tachymeters have been made, but these have not been applied with much success upon locomotives, excepting the Scholkmann system, which has been used on the Prussian state locomotives.

A NOVEL OIL CAN.

Pictured in the accompanying engraving is an oil can of novel construction recently invented by Messrs. Frank W. Clow and Joseph Brooks, of Livingston, Mont. The oil can is of the type used in oiling locomotives and large machinery, in which a long spout is provided to permit of reaching parts which would be inaccessible if the ordinary oil can were used. One of the principal objections to oil cans with long spouts is that in reaching distant bearings or oil cups, a large amount of oil is usually spilled out before the nozzle can be inserted to the desired spot, because, owing to the length of the spout, the can must be tipped up to pass between the various parts of the machine. The present invention seeks to overcome this objection by providing a valve which normally closes the spout, so that the can may be entered into the machinery without spilling a drop of oil, and then when the proper bearing is reached, a thumb piece is depressed, opening this valve and permitting the oil to flow out. In our illustration the spout of the can is broken away, and also a portion of the body of the can, in order to bring out the details. A portion of the upper end of the spout, with the nozzle screwed on, is represented in Fig. 2, and shows the valve that closes the end of the spout. The valve stem passes down through the spout to the bottom of the can, where it is bent upward again to pass through an air-inlet tube to the outside of the can. Here the valve stem terminates in a thumb piece. The bottom of the air-inlet tube is closed by a second valve formed on the same valve stem. A coil spring on the tube is connected to this valve and serves normally to hold it and the flow valve closed. When the thumb piece is depressed, both valves are open and air enters the can through the tube to replace the oil which passes out of the spout. An inverted conical strainer is set into the mouth of the can to exclude all foreign matter from the spout. This strainer is attached to the cap which carries the spout and also the inlet tube, so that the entire mechanism may be removed by unscrewing this cap, and this leaves a large opening through which oil may be poured in without danger of spilling. The construction is such that the oil will not collect in and clog up the spout; but if the valve becomes clogged in any way it may be readily cleaned on unscrewing the nozzle from the spout.



A NOVEL OIL CAN.

Official Meteorological Summary, New York, N. Y., July, 1905.

Atmospheric pressure: Highest, 30.17; lowest, 29.58; mean, 29.97. Temperature: Highest, 96; date, 18th; lowest, 61, date, 27th; mean of warmest day, 86, date, 18th; coolest day, 66, date, 23d; mean of maximum for the month, 82.6; mean of minimum, 68.3; absolute mean, 75.4; normal, 73.9; excess compared with mean of 35 years, + 1.5. Warmest mean temperature for July, 78, in 1901. Coldest mean, 70, in 1884. Absolute maximum and minimum for this month for 35 years, 99 and 50. Average daily deficiency since January 1, — 0.4. Precipitation, 6.01; greatest in 24 hours, 2.74, date, 10th and 11th; average of this month for 35 years, 4.51. Excess, + 1.50; deficiency since January 1, — 1.71. Greatest precipitation, 9.63, in 1889; least, 1.26, in 1893. Wind: Prevailing direction, south; total movement, 7,358 miles; average hourly velocity, 9.9 miles; maximum velocity, 46 miles per hour. Thunderstorms 8th, 9th, 10th, 11th, 13th, 19th, 20th, 30th, 31st. Clear days, 5; partly cloudy, 17; cloudy, 9.

The celebrated grape vine in the conservatory at Hampton Court, England, planted in 1769, had in 1830 a stem 13 inches in girth and a principal branch 114 feet in length, the whole vine occupying more than 160 square yards; and in one year it produced 2,200 bunches of fruit weighing on an average a pound—in all, about a ton of fruit.

Correspondence.

New Nomenclature.

To the Editor of the SCIENTIFIC AMERICAN:

Permit me to suggest two names for new "articles" in daily use.

1. Kinetograph: A photograph or series of photographs for use in kinetoscopes or like machines.

2. Aerogram: A message sent by wireless telegraphy. C. G. DICKSON.

Washington, D. C., August 3, 1905.

The Danger of Lightning in Armored Concrete Constructions.

It is a well-known fact that any constructions made entirely of iron are practically immune against the effects of lightning, as the amount of electricity accumulated in the case of a lightning stroke is allowed to distribute itself over the large surface of the roof, and to flow off to the earth at many places with greatly reduced intensity. As pointed out in a recent article in Beton und Eisen, conditions are quite similar in connection with buildings made entirely of armored concrete, as the discharging current will find the roofing iron and distribution rods of an armored concrete roof, struck by lightning, a good conductor of electricity, so as to flow off to the more substantial girder iron with which the roofing iron is connected by wire meshes. Now, as experience has shown lightning not to be discharged to the earth in a concentrated jet from the place of striking, but to have a tendency to distribute itself to all sides if possible, the electricity will be diffused throughout the roof traversed by a network of iron rods. The electricity being greatly reduced in intensity, will have an excellent opportunity of flowing off to the ground through the round irons inserted in armored concrete columns, thus being communicated to the foundation of the current column, which in turn transmits it to the ground. This shows that neither artificial lightning arresters nor their parts will be required in connection with any construction consisting entirely of armored concrete.

Tests with Haulage System to Economize Air.

At the Fürstlich von Plesschen Colliery, in lower Silesia, electricity has been used extensively underground, but with the idea of avoiding firedamp explosions it has been found necessary to use air motors in all such places that were in the return air-way, or such places that were not directly reached by fresh air. The installation at the Fürstensteiner mines is very extensive, and owing to the use of coal cutters these latter mines have been provided throughout with air mains, and to connect with this system was convenient, whereas it would be necessary to use lengthy cables should the introduction of electricity be contemplated. The material that is derived from the seam or measures having a thickness of 23 feet must be hoisted on the incline and for this purpose it is necessary to use a motor of some kind. The system which has here been introduced is the endless-rope system so that whatever motor is used it can run continuously. A duplex air hoist of the ordinary type with slide valves, is installed but it is impossible to use a cut-off so as to expand the air to any great extent on account of the formation of ice in the exhaust. The motors, therefore, do not work economically and use a great deal of air. To overcome this, as has been tried in other districts, the use of reheating was not deemed advisable on account of the danger from explosions.—Translation of article in Gluckauf, Mines and Minerals.

The Current Supplement.

The current SUPPLEMENT, No. 1545, is commenced with an interesting article on "The Kasarguene Bridge." This Russian bridge is the longest reinforced concrete bridge in the world. "The Steam Turbine As Applied to Electrical Engineering" is by the Hon. Charles A. Parsons, and Messrs. Stoney and Martin. "The Winning Automobiles in the Sixth International Cup Race for the Bennett Trophy" describes the Italian cars. The usual scientific, electrical, and engineering notes will be found in their accustomed places.

John Carbutt.

John Carbutt died July 28 at his home in Philadelphia, aged seventy-three years. Mr. Carbutt went to that city from Sheffield, England, in 1853. He was a chemist, and made scientific photography his life study. The Photographers' Association of America chose him as its first president. He made several inventions, chief of which was the orthochromatic plate. In 1879 he perfected the Carbutt dry plate.

Probably the first iron railroad bridge was built on the Philadelphia and Reading Railroad at Manayunk by Richard B. Osborne, Chief Engineer, in 1845. It was a double-track through bridge, of 34 feet clear span, of the Howe truss type, with cast-iron chord and web braces, the bottom chord and vertical web members being of wrought iron. This bridge was followed by several others of the same type.

THE "BENNINGTON" DISASTER.

The history of the United States navy does not furnish an instance of sudden disaster that appeals so directly to our sympathies as the recent tragedy on the United States gunboat "Bennington;" for although the explosion on the "Maine" in Havana harbor resulted in a greater loss of life, it was known that the ship was engaged on a mission that might end in actual war conditions, and there was, therefore, a proportionate sense of risk attached to it. In the present case, however, the trim little gunboat was about to start on a peaceful mission, and the thought of disaster, and disaster of such an appalling magnitude, was far from the thoughts of any one of the ship's company.

The "Bennington" is a two-masted schooner built by N. F. Palmer & Co., Chester, Pa., in 1890. She is of 1,664 tons displacement and on trial made 17½ knots, with 3,436 horse-power. She carries six 6-inch breech-loading guns, four 6-pounders, four 1-pounders, and two Colts. She is known as an unarmored steel gunboat, her protective deck being only ⅜ of an inch in thickness. She cost originally $490,000, and she carries a complement of eleven officers and 176 men.

At the time of the accident, the "Bennington" was lying in San Diego harbor, and in obedience to orders just received from the Navy Department at Washington, to sail that morning for Port Harford to meet the monitor "Wyoming" and convoy her to San Francisco, she had steam up and was in readiness for departure. Suddenly, without, as far as is known, any preliminary warning whatever, the starboard forward boiler exploded, the top of the lower furnace giving way, and the rush of steam drove the boiler against the boiler astern, which was also forced astern and exploded. As practically the whole complement of the ship was aboard and the majority of the crew were located amidships and forward, the casualty list was a shockingly large one, nearly half a hundred men being killed outright, and a large number of others so seriously wounded that the ultimate number of deaths will probably be not far short of seventy-five. The wrecking of the interior, breaking of valves, etc., caused the vessel to sink, although she was located in such shallow water that she can probably easily be salved.

In view of the fact that Secretary Bonaparte, of the navy, has appointed a special board to make a very thorough investigation, it will be idle and premature to enter into speculations as to where the blame for this shocking disaster is to be laid. It is stated that within the last ten months the Scotch boilers of the "Bennington" have been inspected at least three times, and repairs have been executed which were considered sufficient to keep them in service for a few months longer until new boilers could be given her. If the repairs were adequate there is nothing unusual in this course. At the same time there seems to be little doubt that this ship, like many others in our navy, was suffering from a scarcity of officers, particularly in the engineering department.

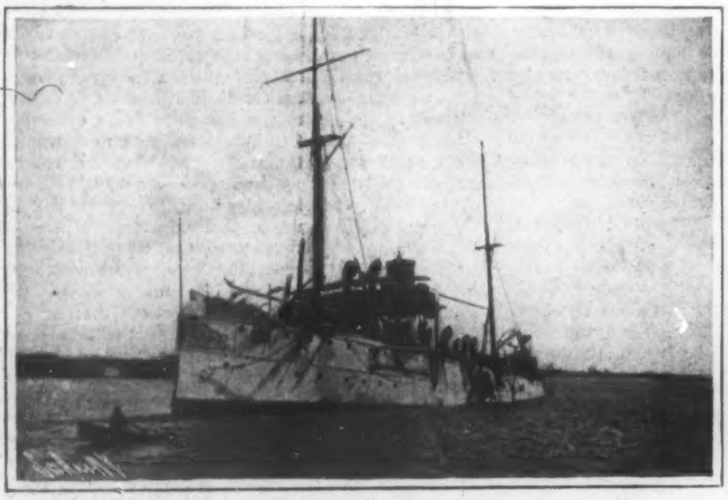
The following discussion of the type of furnace and boiler used on the "Bennington" and its possible bearing on the disaster is from the pen of Mr. Egbert P. Watson, one of the former editors of the Scientific American:

In order to understand the accident clearly a few words of explanation are necessary. The furnaces of marine boilers of the Scotch type are tubes usually four feet in diameter in large boilers and three-quarters of one inch thick. They are corrugated diametrically with about three-inch corrugations for the entire length, and riveted at both ends to the shell of the boiler proper. They are not braced or stayed in any portion, the form, a perfect circle, not requiring it. They have, however, an enormous load to withstand which they are amply equal to under normal conditions. These are that perfectly clean water be fed to them wholly free from any trace of oil or grease. Where these find their way into the boiler, collapse is imminent sooner or later. Twenty years ago, more or less, an epidemic of collapsing furnaces prevailed in the merchant marine all over the seas, and for a long time the cause of it was not discovered. It was at first attributed to scale on the furnace crowns, but examination of injured furnaces did not reveal any scale; they were as clean as when first put in; but an English engineer, Mr. Vivian Lewis, who was consulted on the subject, found that it was oil coming over in the feed water that did the mischief.

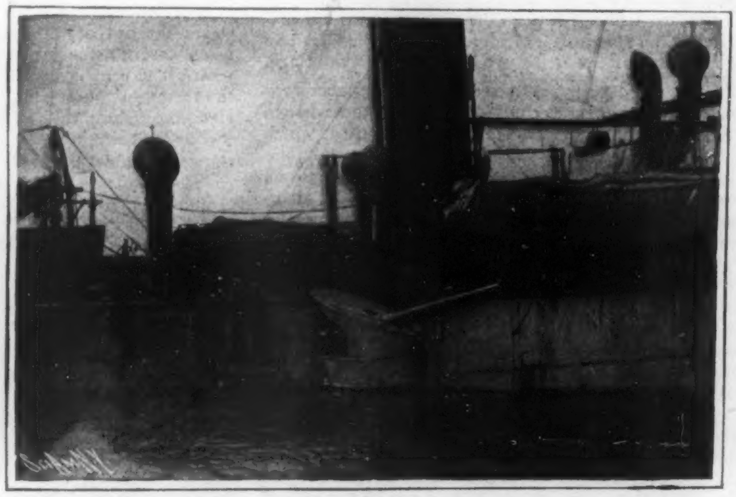
This conclusion was at first combatted by the engineers in charge until it was proven absolutely by Mr. Lewis's analysis and experiments; he asserted that the free oil which contaminated the feed floated around on the surface and caught the scum, of which there is more or less in all boilers; this soon rendered it heavier than water, so that it sank to the bottom or was carried in various directions by the circulation, becoming attached to metallic surfaces, which it happened to strike, with the tenacity of a plaster. This oily mud was a perfect non-conductor of heat and effectually prevented access of water to the plates, so that it was only a question of a short time before they became red-hot and gave way under pressure, forming pockets or bags in the shells of stationary boilers, and deforming marine boiler furnaces. Mr. Lewis proved his contention by making a paste of the deposit in the bottoms of boilers and lining sheet metal pans with it, through which he speedily burned holes even when they were full of water.

The cause of the trouble having been found it was easy to prescribe the cure, which was not to admit oily feed water to steam boilers. This seems very simple as it reads, but it was not so easy to carry out in daily service. Engineers had become so accustomed to using quantities of oil in the cylinders to prevent scoring them that it had become second nature; but imperative orders and one or two collapses, which might easily have resulted seriously, convinced the rank and file that radical changes were necessary. Filters were introduced and more carefully attended to; they were not unknown before, but were so seldom cleaned that they were practically useless, and not until they were looked after by every watch did the disasters here discussed measurably cease. It is very rare now to hear of marine boiler furnaces coming down; when they do it is very certain that remissness occurs in the management. The course generally, or sometimes followed is to jack them back into place. A hot fire is made under the injury and the sheets forced back into place, suitable cast-iron blocks fitted to the corrugations being employed to avoid distorting them. This does not always answer, because it is difficult to bring the furnace to a true circle, in which case it is apt to be deflected again even when no oil is present.

Comment has been made by the daily press upon the alleged neglect to inspect the boilers of the "Bennington" by the Bureau of Steamboat Inspection, but naval vessels are exempt from examination by it, all govern-



Displacement, 1,664 tons. **Speed,** 17.5 knots. **Complement,** 187 officers and men.
Gunboat "Bennington" After the Explosion.



Starboard Side Amidships; the Vessel Sunk to the Bottom, After Explosion. Note 6-inch Midship Gun.

View on Starboard Deck Which Was Awash After the "Bennington" Rested on the Bottom.

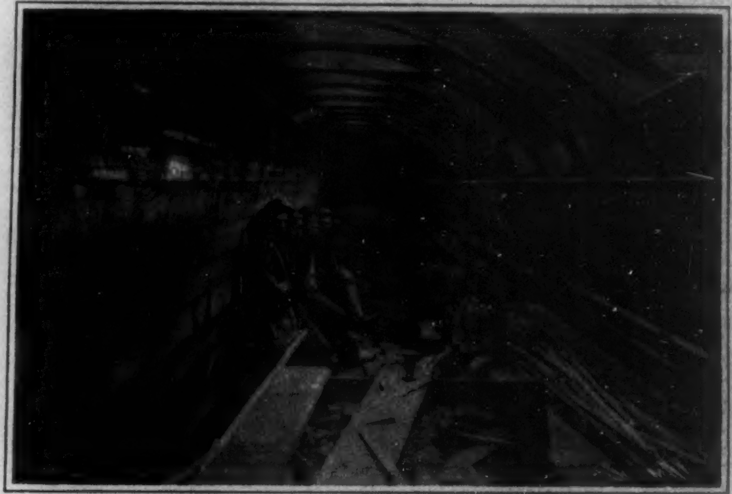
Burial of the Victims in the Military Cemetery at Fort Rosencrans.

THE "BENNINGTON" DISASTER.

The station will be 1,000 feet long, and will contain 18 of these units, developing a total of 180,000 horse-power.

One of the 10,000-Horse-Power Units in the Generating Station.

Sand-Blasting One of the 18-foot Steel Conduits.



Interior of Wooden Form for Concrete Wing-Dam.

Concrete Wing-Dam for Gathering the River Water into the Forebay.

Excavating the Site for the Generating Station at the Foot of the Cliff.

THE 180,000-HORSE-POWER PLANT OF THE ONTARIO DEVELOPMENT COMPANY AT NIAGARA FALLS.—[See page 126.]

ment vessels being inspected by the Navy Department only.

Corrugated furnaces were first introduced to the attention of engineers in 1853-4 by Richard Montgomery, a boiler-maker of the period, at the Morgan Iron Works, in New York city; his examples were, however, defective in that they were corrugated in the flat sheet, afterward bent to a circle and riveted; this left a joint and a flat spot, which was looked upon as dangerous under high pressures. Montgomery's conception of the furnace was all right, but, unfortunately, there was not at that time any way of welding seams, and it was not until the Continental Iron Works, at Green Point, devised a method of doing such work that corrugated furnaces came into general use many years afterward.

ELECTRIC POWER DEVELOPMENTS AT NIAGARA FALLS.—I.

Outside of the technical world it is but little understood how vast are the electrical power plants which are now under construction on the Canadian shore at Niagara Falls. When the Niagara Power Company announced, some dozen years ago or more, its intention of building on the American side of the river a power plant that would develop 50,000 horse-power, the world was incredulous; and not until the first turbine and generator were successfully at work was it willing to believe that the thing could be done. Yet today, not only has the original plant been doubled, but there are in course of construction, and partly completed, turbines and generators installed in three separate plants, that will have a combined capacity over eight times as great as that of the parent plant, while charter rights have been given for the development of power which will amount in the aggregate to over 900,000 horse-power. Named in the order of their size, these three installations are that of the Ontario Power Company, which will develop 180,000 horse-power; the Electrical Development Company, of 125,000 horse-power, and the Canadian Niagara Power Company, which will develop 110,000 horse-power, the latter duplicating the capacity of its original power plant.

The bird's-eye view of Niagara Falls and vicinity on our front page has been drawn with a view to show the location of the new power plants with reference to the Falls. The point of view is from a position over the Canadian shore, and slightly below the steel arch bridge which, a few years ago, took the place of the old highway suspension bridge. We are looking up the river, directly across the Horseshoe Falls, toward the broadly curving Canadian shore, and the rapids which extend for about 3,500 feet back from the crest of the falls. The rapids commence at a point opposite the upper end of Goat Island, and there is a fall of 50 feet in the next 3,500 feet to the edge of the Falls. It is at the head of Goat Island that the Niagara River begins its broad sweep through an angle of over 90 degrees, before discharging its waters over the Falls, and this broad curvature on the Canadian shore, coupled with the rapid rush of the waters, has been taken advantage of by the engineers in selecting the sites for power development. Two of the companies have boldly built out massive wing-dams into the torrent, starting them first at right angles to the shore line, and then curving them upstream at an acute angle with the shore. These wing-dams serve to draw the water in toward the intakes, through which it is led to the supply pipes or the penstocks, as the case may be, for ultimate use in the turbines. The other company has placed its power house at a point where the river was so full and deep that a wing-dam was not necessary, and the water flows directly through the sluice gates into the penstocks. The present article is devoted more particularly to a description of the works of the Ontario Power Company, and the other two installations will be treated at length in later issues.

Just here, however, with this bird's-eye view before us, we will briefly recapitulate the work that has been done at the present time in power development at Niagara. On the New York shore, about a mile above the American Falls, are the two power houses of the Niagara Falls Power Company—one on each side of its intake canal. The original plant is of 50,000 horse-power, and the second power house is of 55,000 horse-power. Each power house is located over its own wheel pit, and the water is conducted through penstocks to turbines in the bottom of the pits, and is led away through a tail-race tunnel over a mile in length, the discharge of which will be noticed in our bird's-eye view, just below the abutment of the steel arch bridge on the New York side. Fifteen hundred feet below the Niagara Power Company's intake canal is a canal which leads through the city of Niagara to a forebay on the edge of the cliff below the steel arch bridge. Here the water is led by penstocks down to the power house of the Niagara Falls Power and Manufacturing Company, which has an ultimate capacity of about 40,000 horse-power. Beginning at the head of the rapids on the Canadian side, we have first the intake of the Ontario Power Company, from which the water is led in underground pipes to the cliff above the generating station, where it is led down to the latter in penstocks and the power is developed on the edge of the river in a generating station that is a thousand feet in length. About 2,000 feet further down the rapids on the Canadian shore is the power station of the Electrical Development Company, where the water is deflected by a wing-dam through a series of screens and gates into penstocks which lead to turbines at the bottom of a huge wheel pit. The tail-race water is discharged by means of a tunnel which has been cut from the bottom of the wheel pit right through below the river to the edge of the falls, discharging at the river level below and back of the falls. About half a mile further down the rapids we see the power station of the Canadian Niagara Power Company, where the water is similarly led through penstocks to the bottom of a wheel pit, and discharged through a tail-race tunnel, whose outlet is just above the surface of the river below the falls and about half way between the falls and the generating station of the Ontario Power Company.

It will thus be seen that on both sides of the river the power plants have been built on two broadly different systems, one consisting in sinking a huge wheel pit to a level sufficiently higher than that of the river below the falls to allow of an easy delivery for the tail-race waters, and placing the turbines at the bottom of this pit, and the generators at the top of it at the level of the power house; the other method consists in carrying the waters from the upper level of the river by means of a canal or pipes and penstocks to a power station located on the shore of the lower river and at a sufficient height above the latter to give the proper clearance for the draft tubes.

ONTARIO POWER COMPANY DEVELOPMENT.

In the year 1887 the government of the Dominion of Canada made a grant to the Ontario Power Company for the development of hydraulic power at Niagara Falls, these concessions being made contemporaneously with the first concessions granted in the United States. Briefly stated, the works consist of a large system of intakes located abreast of the commencement of the upper rapids, and near what are known as the Dufferin Islands. These consist of an intake proper, an outer forebay, a system of screens, an inner forebay, and control gates. The intake, which is 618 feet long, extends diagonally from the shore out into the river, and consists of a series of concrete piers which carry a concrete curtain wall. This wall extends vertically downward 7 feet below the surface of the river, to within 6 feet of the river bed, and it projects 5 feet above the river level. The water passes through the intake in the 6 feet of space between the river bed and the under side of the curtain wall. As the river rushes along the curtain wall, its current is increased and the masses of ice that come down in the winter time are swept along the face of this wall, only a part of the water passing through and beneath it into the outer forebay, which contains an area of 8 acres. This forebay is bounded on the shore side by an artificial island; on the river side toward the falls, it is bounded by a massive wing-dam, of which we present an illustration. This dam extends out into the river at the lower end of the forebay with a broad curve and swings around upstream to meet the lower end of the intake curtain wall. Except during extremely low stages of water, the wing-dam will be constantly submerged, the water spilling over it into the river, as over a weir, and carrying with it such floating ice and debris as may pass through the outermost intake. The section of the wall 100 feet in length which is adjacent to the screen house, has its crest lower than the rest of the dam, thus forming a spillway of increased capacity at that point. Its effect is to create a strong surface current across the front of the screens, and sweep out into the river all ice that may have passed the ice curtain and escaped the general spill over the wing-dam.

From the inshore end of the wing-dam a series of massive screens have been built across the entrance to the inner forebay, which has an area of two acres. They are set on inclined guides in concrete masonry, and are removable by means of a crane. The gear for handling the screens, etc., is inclosed in an artistic stone building, on the roof of which is a broad promenade from which a magnificent view of the rapids may be obtained. After passing through the inner forebay, the water is conducted through three massive gates into three gigantic steel conduits, or water pipes. The gates are of the Stoney pattern. They are square in form, are counterbalanced, and run between roller-guides. As will have been judged from the foregoing description, the capacity of the head works is very large. Indeed, when the entire capacity of the plant is being generated, the flow of water will be 12,000 cubic feet per second. The depth of water increases gradually from 13 feet at the intake to 30 feet at the gate house. It should be explained that the designs of all the buildings throughout the works have been approved by the park commissioner, and they have been drawn to harmonize with the landscape gardening effects in the park.

Starting from the main gate house, the water will be conducted in three 18-foot steel conduits for a distance of about 6,200 feet to the top of the bluffs below the Canadian Falls. Of these three, the first has been completed. It is built of half-inch steel plates, and to secure additional stiffness 7-inch bulb-deck beams are riveted to the upper half of the pipe at every four feet, and the whole is incased in a thick layer of concrete. To insure that the conduits shall not interfere with the appearance of the park, they are being laid in trenches and will be entirely covered from view.

The first of these conduits is completed. From the under side of it six 9-foot penstocks are carried down in pairs through vertical shafts and out through horizontal tunnels in the solid rock of the cliff to the generating station. Each penstock supplies water for a 10,000-horse-power unit. The vertical depth from the center of the conduit to the center of the turbine is 133 feet. Two small penstocks of 30 inches diameter lead from the main conduit through an inclined tunnel to the power house, and supply water for the two exciter turbines.

It will be seen from the above description that this installation is entirely different from that of the Niagara Power Company on the New York side, in that it does not employ a wheel pit. The generating station is located on a bench at about the normal level of the river, which has been cleared of rock at a point about 700 feet down stream from the Canadian Falls. This building is 76 feet wide, 65 feet high, and when it is completed will be 1,000 feet in length. The main generators and their turbines are placed on the floor of the station 20 feet above mean water level. Each turbine unit consists of a pair of Francis turbines, mounted, side by side, on the same horizontal shaft that carries the generator, and operating at 187.5 revolutions per minute, at a rated horse-power of 11,400. After passing through the wheels, the water flows through concrete draft tubes, which terminate in tail-races built in the foundations of the station. These, in turn, discharge over a weir wall into the river. The crest of this weir wall is at elevation 349. Under full load conditions the water rises on it to elevation 353, giving a gross head between forebay where the water level is at elevation 553 and tail-water level of 200 feet. Of this head 175 feet is effective on the turbines. The first installation, which is now nearing completion, consists of six of the twenty main generators provided for by the general plan. Each generator is rated at 7,500 kilowatts, and delivers three-phase current of twenty-five cycles at 12,000 volts. The generators are of the rotating field type, the external diameter of the armature being about 21 feet. On a raised gallery which extends down the power house on the side opposite the river, are located the exciter turbines, the direct-connected exciting dynamos, and the turbine governors.

An entirely new feature in this power house is that the actual operation of the generating station is conducted from a separate distributing and control station, located at a distance from the generating station. This building is 550 feet inshore from the generating station, and stands on the bluff at an elevation of 250 feet above it. The control circuits pass from the generating station in insulated cables, carried through inclined tunnels in the cliff, which extend to a point on the hillside a little above the main conduits. Thence they are carried up the bluff, under ground to the distributing station. Here, in a separate switch room, the 12,000-volt automatic oil switches are mounted in brick cells. They are of the vertical plunger type and are magnetically actuated.

The transformers are arranged centrally throughout the length of the distributing station building, except at the center of the building, where space is given to the control room. Each transformer is rated at 2,500 kilowatts, or 3,350 horse-power, and they weigh 40 tons apiece. They are designed for a potential of 60,000 volts.

It is anticipated that as construction proceeds the foregoing plans will be modified to provide for 200,000 horse-power ultimate capacity, with 22 units of 10,000 horse-power each in the installation.

We are indebted for our information to P. N. Nunn and L. L. Nunn, the engineers of the company, who are responsible for the design and execution of this great work.

E. H. R. Green, of Dallas, Texas, one of the leading citizens of the State and president of one of the railroads of that section, and who enjoys the additional distinction of being the son of the famous Hetty Green, of New York, has gone in for automobiling as a pastime, with the result that he has designed an electric system for the timing of automobiles on the racetrack. It is said to be extremely simple in its construction and application, and can be laid down upon any course without any elaborate preparation. As the vehicle passes certain points along the course, a record is made of the time at the judges' stand at the starting point. The system involves the use of the wireless method.

AWARD OF THE GLIDDEN TROPHY FOR TOURING CARS.

Of the thirty-two machines that started from New York in the Glidden touring contest to the White Mountains and back on July 11, twenty-eight returned to the starting point on July 22. But two of the four machines that were missing at the finish dropped out because of breakdowns. One of these breakdowns resulted from an accident occurring the first day of the tour. The driver of a White steamer, Mrs. J. H. Cuneo, was obliged to run her machine off a 6-foot-high bridge in order to avoid a collision with another car, the result being that although the steamer (which fell on its side) was damaged somewhat, its plucky driver was able to run it and make a fairly good score until the last day of the tour, when the machine gave out completely with a broken water pump and driving shaft. The only other car which failed to finish on account of mechanical troubles was Mr. S. E. Hutchinson's 50-horse-power Panhard, which broke its crank shaft. One of the most remarkable accidents during the tour happened at North Conway, N. H. Mr. C. J. Edwards was driving his large four-cylinder Cadillac machine at a rapid rate of speed when, after rounding a curve, he came suddenly upon a covered bridge. The car slewed so that the hub of the front wheel struck an inclined beam at the entrance to the bridge, and, as it traveled up the beam, raised the car and turned it upside down. Although found under the machine, none of the occupants was seriously injured. The steering gear was damaged somewhat, but this was repaired and the day's journey completed.

As the tour was originated by Mr. Glidden for the purpose of bringing out the reliability and comfort of the modern touring car it was unfortunate that many of the entrants could not refrain from bursts of speed in an endeavor to reach the end of their daily destination first. The accident just cited was the result of speeding over a highway which was unfamiliar to the motorist, and that it did not have serious consequences can be laid only to luck.

Had the motorists all run with the precaution that was shown by Mr. Percy E. Pierce in driving his 28-32-horse-power touring car, there would not have been as many breakdowns on the road as there were and the competition for the trophy would doubtless have been much keener. As it was, however, the breakdowns were few in number and of slight consequence, and even the tire troubles were found to be much reduced over what have been usually experienced on runs of this character. Some of the troubles experienced by the various cars consisted of broken connecting rods, fouled spark plugs, broken-down spark coils, a broken rear spring (on the Packard truck), a chain jumping off the sprocket, and the giving c . of a high-pressure hose. None of these repairs, with the exception of the broken connecting rods, necessitated very lengthy delays, and in almost every instance the car was soon going again.

The steepest hills were experienced at the Crawford Notch, N. H., and in the run from Springfield to Lenox, Mass., in the course of which the famous Morey Hill, which has an elevation of 146 feet and grades of nearly twenty-five per cent, was ascended. Despite the steepness of this hill and the poor character of the road, all the cars ascended it with practically no difficulty. Most of the larger cars were obliged to climb it on their low gear, while the lighter touring cars, fitted with two-speed planetary transmissions, were able to rush the hill the first part of the way and go considerably further than the others before dropping to their low gear. Had the test been carried out along scientific lines, this hill would have been a fine one on which to demonstrate the horse-power actually developed by the various machines. The fact that all climbed it with little or no difficulty, however, shows that the American machine of to-day has ample power for touring the most mountainous districts.

A very interesting feature of the Glidden tour, and one which should serve as a thorough demonstration of both the air-cooled and water-cooled type of commercial vehicle, was the performance of two trucks entered by the Knox Automobile Company and the Packard Motor Car Company. These vehicles were started every morning at an early hour, and they generally reached their destination late in the afternoon. They carried a considerable amount of baggage belonging to the tourists, and so reliable were they that after the first two days the contestants preferred to use them to the express companies. A picture of the Knox truck ascending Morey Hill is shown herewith, as well as a photograph of the Packard truck on top of Mt. Washington—a climb which is as noteworthy to-day for a commercial vehicle as was the ascent of Pike's Peak by a steam runabout some years ago.

The Knox truck is fitted with a standard double opposed cylinder 5 x 7 Knox horizontal air-cooled motor of 16 horse-power. It has a wheel base of 95 inches, a tread of 56 inches, and 32 x 3½-inch solid tires. Its maximum speed is 18 miles an hour, and its carrying capacity is 2,500 pounds. Besides the driver and his assistant, this wagon hauled daily from 1,200 to 1,500 pounds. The total distance it covered in the course of the tour (which distance included several side trips in the vicinity of Mt. Washington) was 1,001¼ miles, which was covered in 63 hours and 25 minutes, at an average speed of 14⅘ miles per hour; 107¼ gallons of gasoline and 4½ gallons of cylinder oil were used, and the only replacements were two chain links and one exhaust valve. With gasoline at 20 cents a gallon and oil at 50 cents this figures out the total expense at $27.58, or an average cost of 2¾ cents per mile. This is certainly a very favorable showing for a light-weight gasoline truck.

The Packard truck was fitted with a 15-horse-power twin-cylinder vertical engine having 4 1-16 x 5-inch cylinders. A three-speed sliding gear transmission and a double chain drive from countershaft to rear wheels are employed. During the course of the run this machine covered 865 miles on a total consumption of about 79 gallons of gasoline, which is equivalent to 10.95 miles per gallon; 5.5 quarts of cylinder oil were used, which equals 145 miles per quart. The load the first day was only about 2,000 pounds, but afterward the truck carried around 3,200. No great trouble was experienced in driving this heavy vehicle through the country, although it skidded some on mountain roads after a heavy rain. In climbing Mt. Washington chains were used on the rear wheels. These broke two separate times and the ends flew up and caught in the driving chain, thus breaking it. Within three miles of the summit the truck ran into a heavy sleet storm which put out the oil lamps and left the motorists only one acetylene headlight to see by. Despite climbing the mountain under such bad conditions the truck reached the summit in 4¾ hours. The start was made at 6 P. M. and the halfway house was reached about 7. After leaving that point it was overtaken by rain, which made traction very uncertain. A bad stretch of sandy road was then encountered and here the chains were put on. These served their purpose well until they broke with the result mentioned.

The Glidden trophy (which consists of a large globe supported on a suitable pedestal and surmounted by an automobile) was awarded to the Pierce touring car shown herewith. This car is a typical American touring car, having a bevel gear drive and a 4¼ x 4¾ four-cylinder motor. Including a 1,580-pound load, it weighed 4,280 pounds. It climbed Mt. Washington twice and completed the tour besides, without at any time experiencing any mechanical or tire trouble whatever.

The Trophy Winner.—A Pierce "Arrow" Touring Car.

This car has a 104-inch wheel base. It is provided with a bevel-gear drive and 28-32-horse-power, four-cylinder motor.

Knox 16-Horse-Power Truck Climbing a Grade of 28 Per Cent on Morey Hill.

This truck has a carrying capacity of 1¼ tons. It is propelled by an air-cooled motor, and has a two-speed planetary transmission.

The 15-Horse-Power Packard Truck, Which Climbed Mount Washington in About 2 Hours Running Time.

This is a 1½-ton truck. Weight, 2,800 pounds. Motive power, two-cylinder vertical engine and three-speed sliding-gear transmission.

THE WINNING TOURING CAR AND THE MOTOR TRUCKS IN THE GLIDDEN TROPHY TOUR.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.** MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 7133.—For the address of the importers of wire called "meteor" wire, used for the ignition points on igniters for explosive engines.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 7134.—Wanted, a machine for making and pressing yeast.

2d-hand machinery. Walsh's Sons & Co., Newark, N.J.

Inquiry No. 7135.—For makers and dealers in novelties and newly patented articles.

Perforated Metals, Harrington & King Perforating Co., Chicago.

Inquiry No. 7136.—Wanted, a 75-foot steel flag pole or staff.

Adding, multiplying and dividing machine, all in one. Felt & Tarrant Mfg. Co., Chicago.

Inquiry No. 7137.—For the manufacturers of the Tripoli Stone Filter.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 7138.—Wanted, machinery, etc., for converting waste wood into tar, turpentine and charcoal.

Marketers of meritorious inventions and specialties throughout the world. Tatem Mfg. Co., Buffalo, N. Y.

Inquiry No. 7139.—For the address of the Lawry Press Co., manufacturers of hay balers.

I sell patents. To buy them on anything, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 7140.—For parties to manufacture toy balloons capable of lifting two pounds.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

Inquiry No. 7141.—For makers of machines for felling trees, with the use of hot wires.

Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

Inquiry No. 7142.—For the makers of stepdown transformers of 25 cycles, from 15,000 volts to 110 or 125 volts, with an output capacity of 100 amp. oil-cooled pole type.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, wood fiber machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 7143.—For makers of engines for changing farm wagons and top buggies into traction vehicles.

Absolute privacy for inventors and experimenting. A well-equipped private laboratory can be rented on moderate terms from the Electrical Testing Laboratories, 548 East 80th St., New York. Write to-day.

Inquiry No. 7144.—For firms in the United States manufacturing apparatus for the dry distillation of wood, for producing alcohol, charcoal and other products.

Manufacturers of all kinds sheet metal goods. Vending, gum and chocolate, matches, cigars and cigarettes, amusement machines, shade of pressed steel. Send samples. N. Y. Die and Model Works, 508 Pearl St., N.Y.

Inquiry No. 7145.—Wanted, manufacturers of gold brilliant sign letters stamped from copper plate, concave, finished inside with gold leaf, used on inside of glass or show windows.

WANTED.—To buy ideas or patents for new articles to manufacture as a side line. Will consider all propositions, but prefer articles commonly used by the populace. Briefly give full particulars. F. Raniville Co., Grand Rapids, Mich.

Inquiry No. 7146.—Wanted, a meter for measuring gasoline gas.

WE WANT MACHINE SHOP WORK.—Also nickel and oxidized bronze plating. Have big shop and best facilities for pattern work, die-making and all kinds machine work. Large contracts wanted. Michigan Automobile Co., Ltd., Kalamazoo, Mich.

Inquiry No. 7147.—For manufacturers of a weight motor or blower to be used in connection with gasoline lighting system.

QUANTITY CLERK WANTED.—In the office of a large ornamental iron and bronze manufacturing company. A man understanding plans. Opportunity to develop from drafting office to quantity and estimating clerk. Address Clerk, P. O. Box 773, New York.

Inquiry No. 7148.—For makers of small, wooden boxes.

Young man, practical engineer, large acquaintance, desires to represent manufacturer on Pacific coast on commission basis; can furnish best of references as to industry, character and ability. Address W. Brown Smith, 630-632 Laughlin Building, Los Angeles, Cal.

Inquiry No. 7149.—For information in regard to the manufacture of paper bottles.

PATENTS ON DREDGES AND DREDGING MACHINERY FOR SALE.—By reason of the death of Ralph R. Osgood, valuable patents, having a long term to run, are offered for sale. For terms communicate with The Albany Trust Company, Executor, Albany, N. Y.

Inquiry No. 7150.—For makers of small wooden articles turned out of wood.

A PAPER PROPOSAL.

Is the title of a clever little love story published by the LACKAWANNA RAILROAD solely on its merit as a bright piece of fiction. It is contained in a beautifully illustrated book of one hundred and twenty-eight pages which describes some of the attractive vacation places along the lines of that road.

The book may be had by sending ten cents in stamps to T. W. LEE, General Passenger Agent, New York City.

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